



S-0110P-A

**CAP RATE-ADAPTIVE  
ETHERNET DSL  
REMOTE UNIT (ATU-R)  
A90-36R210**



SuperVision® System Manual  
*CAP Rate-Adaptive Ethernet DSL Remote Unit*  
**A90-36R210W00**

Part # 030-1010xx  
**A90**  
Rev. **P2**, 07/01/98



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**CAP RATE-ADAPTIVE ETHERNET DSL  
 REMOTE UNIT WITH FLASH  
 (ATU-R)**

**1. General Description**

The Ethernet DSL remote unit (ATU-R) (A90-36R210W00) terminates a DSL line at the subscriber location. The 10BaseT Ethernet DSL system uses Carrierless Amplitude Phase Modulation (CAP) transmission to provide reliable DSL transport over the existing copper cable infrastructure. The ATU-R separates CAP high-speed downstream and lower-speed upstream channel data and POTS (Plain Old Telephone Service) signals which have been transported via twisted-pair copper wires between an access line module at the central office and the subscriber premises. The ATU-R provides an industry standard 10BaseT interface to the customer's CPE equipment. Application software is fully downloadable to allow for future enhancements. The ATU-R is available with or without an optional internal POTS splitter.

ATU-R Options		CLEI	FCC ID Number
A90-36R210	Without Internal POTS Splitter	VARTFMD1AA	CH8AR210

**2. Document Control**

Whenever this section of the manual is revised, the reason will be stated in this subsection. Each time a revision is made, the revision level (located in the upper right corner) will be increased by one letter. In addition, any changes in fit, form or function of the equipment will cause the issue letter (located in the upper right corner) to be increased. An explanation of the equipment changes will also be made in this subsection. See the *Overview* section of this manual for additional information.

**3. Build Control**

The remote unit (ATU-R) is identified by an issue letter and model number imprinted on the bottom of the unit. Each time a change is made to the product which changes the form, fit or function of the product, the issue letter is advanced. Be sure to indicate the unit's issue letter and model number when making inquiries about the product. The release number in the bottom left corner indicates the release(s) for which the module or section is valid.



## A90-36R210-xxx

Issue Number    Model Number    Last three digits indicate  
 POTS Splitter options.

A90-36CP21R	xxx	
	W00	No internal POTS splitter
	NA1	North American POTS Splitter

S-0146-A

### 4. Compatibility

Refer to the System Overview (030-100983) section, Paragraph 5, for a complete list of all system element compatibility.

### 5. Inspection

Upon receipt, thoroughly inspect the remote unit for damage. If the remote unit has been damaged during transit, please report the damage immediately to the transportation company and to your Westell representative. Responsibility for safe delivery of goods is assured by the transportation carrier. Refer to the *SuperVision Service/Technical Support* Section of this manual for further information.

### 6. Product Overview

The remote unit is located at the subscriber's premises and terminates the digital subscriber line originating from the (ATU-C) in the central office.

The software within the ATU-R completely controls the hardware by providing an embedded system that implements a multiport learning MAC layer bridge that interfaces between Logical Link Control/Subnetwork Access Protocol (LLC/SNAP) AAL5 encapsulated ATM cell-based, bridged protocol data units (PDUs) and 10BaseT Ethernet frames. The AAL5 layer is the layer that supports connection-oriented, variable-bit-rate data services such as the typical "bursty" data traffic found in today's LANs. The LLC sublayer handles error control, flow control, framing, and MAC-sublayer addressing.

#### 6.1 Features and Functions

The ATU-R provides a flexible platform for providing DSL services and applications. These features include:

- No in-home configuration required. Once the ADSL line is provisioned by the telco, the ATU-R is plug-and-play.



- Utilizes RADSL technology which supports rates from 640 kbps to 7.1 Mbps downstream and 91 kbps to 1.088 Mbps upstream.
- Available options include internal POTS splitters customized to country-specific POTS specifications or no internal POTS splitters where an external splitter is preferred.
- Support for fully automatic rate adaptation upon power-up, as well as support for fixed rate operation.
- Translation between Ethernet MAC frames and LLC/SNAP AAL5 encapsulated ATM bridged PDUs. In the ATM environment, this means that a PDU is sent through each relevant virtual circuit (VC).
- 10BaseT Ethernet interface on customer side with high-speed ADSL-based network side.
- Support for up to eight simultaneous connections via ATM PVCs.
- Status indicators via front panel LEDs.
- Multiport MAC layer learning bridge implemented in software. The bridge associates a destination MAC address with an ATM PVC.
- Support for statically provisioned MAC addresses.
- Programmable handling of Ethernet broadcast and multicast frames.
- Programmable ATM QoS parameters for upstream traffic (towards network).
- Offers centralized, software-controlled configuration, diagnostics and performance monitoring.
- System software is fully upgradable via a standard web browser.

## 6.2 Transmission

The system uses Carrierless Amplitude Phase Modulation (CAP) technology to deliver from 640 kbps to 7.1 Mbps downstream and 91 kbps to 1.088 Mbps upstream for data, while simultaneously providing lifeline POTS (Plain Old Telephone Service). Upstream is defined as from CPE to network and downstream from network to CPE.

The following table defines the DSL speed values at which the unit is capable of operating.



DSL Rate Upstream	DSL Rate Downstream
91 kbps*	640 kbps
272 kbps*	960 kbps
408 kbps	1.28 Mbps
544 kbps*	1.6 Mbps
680 kbps	1.92 Mbps
816 kbps*	2.24 Mbps
952 kbps	2.56 Mbps
1088 kbps	2.688 Mbps
	3.2 Mbps
	4.48 Mbps
	5.12 Mbps
	6.27 Mbps
	7.168 Mbps

*\*This upstream rate is not valid when the downstream rate is above 2.56 Mbps*

### 6.3 Configuration

The ATU-R supports numerous programmable options which can be configured through an element-management system. The configurable options include:

- **PERMANENT VIRTUAL CIRCUIT (PVC) NUMBER** – Assigns the number of the ATM permanent virtual circuit. Defaults to zero (range 0 - 8).
- **VIRTUAL PATH IDENTIFIER (VPI) NUMBER** – An 8-bit field in the ATM cell header that indicates the virtual path over which a cell is to be routed. It is the VPI address of the PVC. Defaults to zero (range 0-255).
- **VIRTUAL CHANNEL IDENTIFIER (VCI) NUMBER** – The unique numerical tag used to identify every virtual channel across an ATM network, defined by a 16-bit field in the ATM cell header. It is used for the addressing information carried on ATM cells. Indicates the VCI address of the PVC. Defaults to zero (range 0 - 65,535).
- **PEAK CELL RATE (PCR)** – A traffic management parameter that determines how often data samples are sent. Defaults to 3600 cells per second (range 0-30,000).
- **CELL DELAY VARIANCE TOLERANCE (CDVT)** – A network descriptor parameter that characterizes the delay jitter/cell clumping that can be encountered by cells in the network and CPE devices. It is used in conjunction with PCR and SCR. Defaults to zero (range 0 - 255). Measured in cell times.





- **SUSTAINABLE CELL RATE (SCR)** – Determines the long-term average cell rate that can be transmitted. Default is 3600 cells per second (range 0 - 30,000).
- **MAXIMUM BURST SIZE (MBS)** – Defines the maximum cell burst size at the peak cell rate (PCR). Default is zero (range 0 - 255). Measured in cells at the PCR.
- **BRIDGE MODE** – Static or Learned. Default is learned.
- **UPSTREAM CELL RATE (UCR)** – Defines the upstream cell rate in cells per second. Allows for control of upstream data at the ATM layer as opposed to the DSL line rate when set to 0. Upstream cell rate equals DSL line rate. Default is 0, (range 0 - 30,000).
- **BRIDGE AGING INTERVAL** – Determines the length of time a MAC-to-ATM PVC binding is stored in bridge before a refresh is needed. Default is 1800 seconds (range 0 - 65,535 seconds).
- **MAC ADDRESS** – A 48-bit MAC address. Up to 16 addresses can be provisioned to use with static bridge mode operation.
- **UPSTREAM TRANSMIT POWER** – Upstream transmit power can be programmed from 0 dB to -12 dB in 3-dB increments from typical transmit power of -13.3 dB. This means maximum upstream transmit power can be set in the range of -13.3 dB (0 dB  $\Delta$ ) to -25.3 dB (-12 dB  $\Delta$ ).

#### *PER PVC PARAMETERS*

**ENABLE/DISABLE FORWARDING OF ALL ETHERNET BROADCAST FRAMES** – An Ethernet Broadcast frame is a data packet that will be sent to all nodes on a network. Broadcasts are identified by a broadcast address. Generally, the broadcast address is a destination address of all ones. Default is Disabled (only forward IP broadcasts).

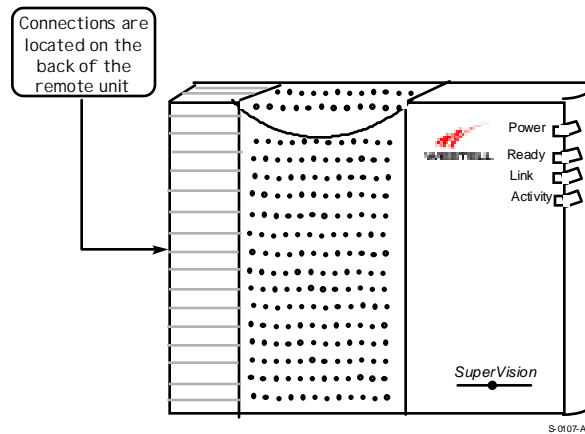
**ENABLE/DISABLE FORWARDING OF ALL ETHERNET MULTICAST FRAMES** – A multicast frame is a data packet copied by the network and sent to a specific subset of network addresses. These addresses are specified in the destination address field. Single addresses that refers to multiple network devices. Synonymous with group address. Default is Disabled (on multicasts forwarded).

**ENABLE/DISABLE ETHERNET FRAME CHECK SEQUENCE (FCS) PRESERVATION** – Frame check sequence refers to the extra characters added to a frame for error-control purposes. It is used in most data link-layer protocols. The Ethernet FCS consists of four extra characters at the end of the frame. Default is Disabled (FCS not preserved).

**ENABLE/DISABLE THIS PERMANENT VIRTUAL CONNECTION (PVC) FOR BROADCAST FRAMES ONLY** – Virtual circuit that is permanently established between two points. PVCs save bandwidth associated with circuit establishment and tear down in situations where certain virtual circuits must exist all the time. PVCs are provisioned between the ATU-R and network switching elements. Default is Disabled (normal PVC).

### 6.4 ATU-R Indicators

Figure 1 shows the 10BaseT Ethernet DSL Remote Unit.



**Figure 1. Ethernet DSL Remote Unit (Top)**

The Ethernet remote unit has four LEDs on the front panel that allow for verification of the operation and status of the remote unit, and transmission and receive

pt of data. The green POWER LED and two-color (red and green) READY LED, when lit, gives an indication of the unit's operation/status as well as the network DSL connection. The green LINK LED, when lit, provides an indication that the 10BaseT link between the ATU-R and the CPE is established and the yellow ACTIVITY LED, when lit, indicates whether transmit or receive Ethernet data is present on the LAN.

The LEDs have the following states:

#### POWER

State	Description
Steady Green	Power ON
No Light	No power

**READY**

State	Description
<b>Slow Flashing Green</b>	Power ON and passed power-up diagnostics (1 flash/sec)
<b>Moderate Flashing Green</b>	Power ON and attempting synchronization (2 flashes/sec)
<b>Fast Flashing Green</b>	Power is ON and synchronized with the ATU-C and downloading operational sequence (4 flashes/sec)
<b>Steady Green</b>	Power ON and synchronized with ATU-C
<b>Steady Green/ Intermittent Red</b>	Power is ON and synchronized with ATU-C, but a line error condition was detected
<b>Steady Red</b>	Unit diagnostic failed
<b>Blinking Red</b>	Unit failed power-up diagnostic
<b>No Light</b>	No power

**LINK**

State	Description
<b>Steady Green</b>	Link established
<b>No Light</b>	No 10BaseT link

**ACTIVITY**

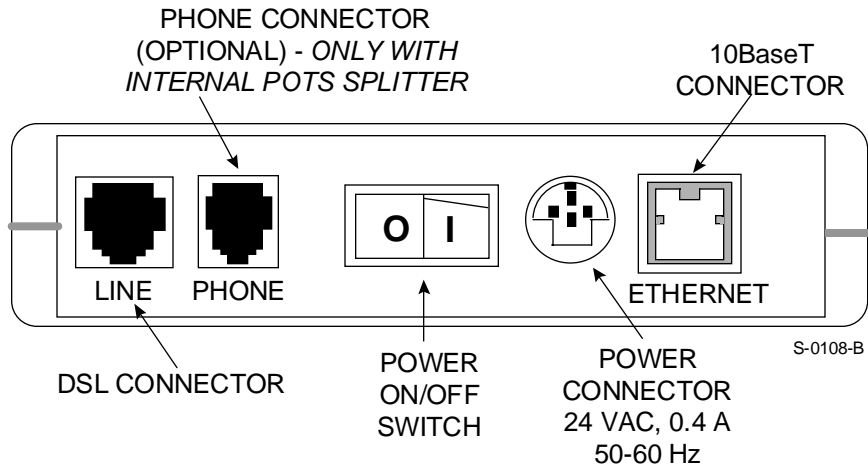
State	Description
<b>Pulsing Yellow</b>	Traffic is being transmitted. Pulses should match the receipt or transmit of Ethernet data
<b>No Light</b>	No traffic

**6.5 Interfaces and Connectors**

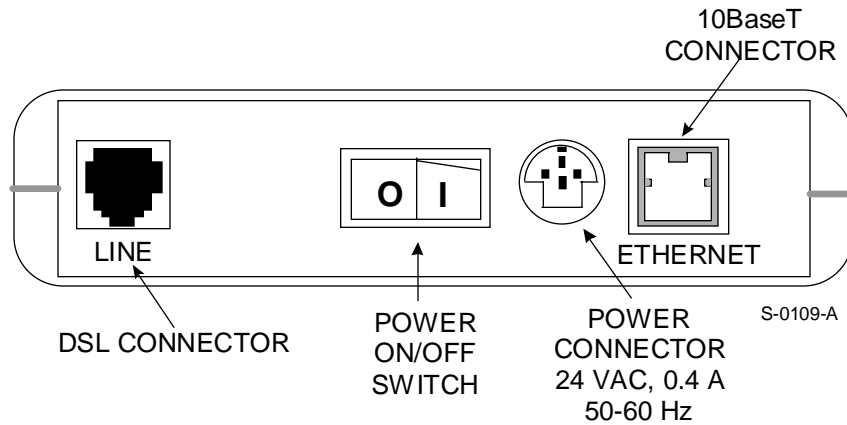
On the rear panel, the ATU-R has a power ON/OFF switch, connectors for power, POTS/DSL, a phone and customer terminal equipment port. **Figure 2** shows the ATU-R's side panel.

Connectors		
NAME	TYPE	USE
Power	MINI-DIN connector	Power
Line	one 8-pin modular jack	POTS/DSL
Phone	6-pin modular jack RJ11	POTS
Ethernet	8-pin RJ45 jack	Ethernet (customer terminal equipment option)

**Figure 2** shows the connector side of the ATU-R with the optional phone connector shown. **Figure 3** shows the side panel without POTS splitter. The phone jack is not provided on the unit without internal POTS.



**Figure 2. Rear Panel of 10BaseT Ethernet DSL Remote Unit *with* Internal POTS Splitter**



**Figure 3. Rear Panel of 10BaseT Ethernet DSL Remote Unit *without* Internal POTS Splitter**

Pinout for Alternate POTS (Phone - RJ11)	
1	Not Used
2	Not Used
3	<b>Phone Tip</b>
4	<b>Phone Ring</b>
5	Not Used
6	Not Used

A connector is provided on units with an internal POTS splitter only.

Pinout for DSL	
1	Not Used
2	Not Used
3	Not Used



Pinout for DSL	
4	DSL Tip
5	DSL Ring
6	Not Used
7	Not Used
8	Not Used

DSL connector designed to operate with either an 8-pin or 6-pin standard cable.

Pinout for 10BaseT interface	
1	Rx+
2	Rx-
3	Tx+
4	Not Used
5	Not Used
6	Tx-
7	Not Used
8	Not Used

## 6.6 Signals

**ATU-C to ATU-R** – POTS and DSL signals are sent from the access line module at the central office to the ATU-R over the digital subscriber line. The POTS signal is carried in the voice band frequency range, 0 to 4 kHz, that is specified by the telephone network voice switch. The ADSL video and data signals are carried in the frequency range above 35 kHz (out-of-voice band). The upstream channel occupies the frequency range between 35 kHz and 170 kHz. The downstream channel occupies the range above 240 kHz and below 1.551 MHz.

**ATU-R to Subscriber** – The ATU-R receives the modulated signal from the access line module and then separates the POTS signal from the DSL signal. The POTS signal is routed to the subscriber's telephone. The ATU-R demodulates the DSL signal and routes it to the PC or other user equipment via an 10BaseT interface.

## 6.7 10BaseT Ethernet DSL Diagnostics

The system includes built-in diagnostics that may be invoked through the element-management system. Diagnostics are performed at the card level on an individual basis and results are sent back to the EMS system.

The Ethernet DSL system provides the unit self-test diagnostic to facilitate trouble isolation and restoral. Unit self-tests verify the operation of the units themselves and are used to determine whether the equipment is causing specific problems. When card-level diagnostics are performed, the cards and circuits under test are taken out-of-service.



Test results are displayed as each diagnostic routine completes. Diagnostic self-tests are performed upon start-up, and then only when requested by the element-management system. This diagnostic causes the DSL loop to go through a retraining sequence and is considered to be intrusive diagnostics.

## 6.8 System Status and Performance Management

The CAP DSL system utilizes a Reed Solomon forward error correction (FEC) algorithm and a convoluted interleaver to improve performance on noisy transmission lines.

The ATU-R can verify connectivity to the central office line and via loopbacks of F5 OAM cells. Upon receiving this cell through the ADSL interface, the ATU-R will loop back this cell to the originator via the ADSL network interface.

On normal power-down, the ATU-R will generate a “dying gasp” message to the ATU-C to indicate a power-down status.

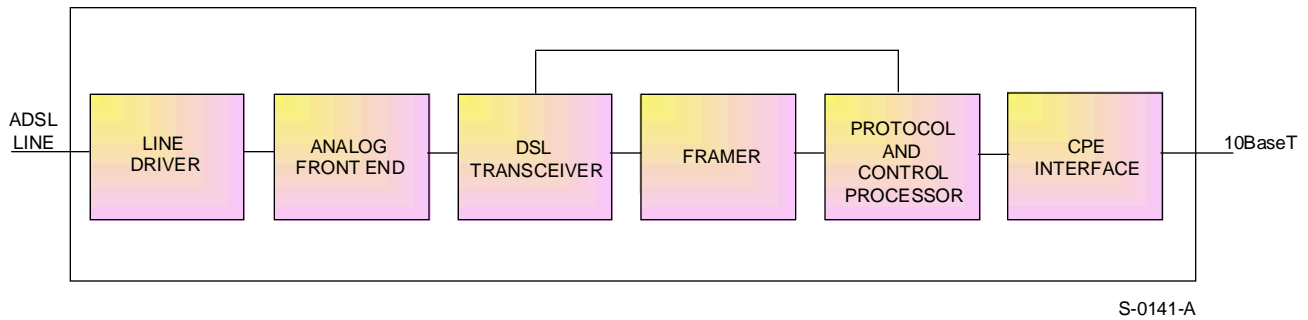
A visual indicator on the front panel READY LED provides an indication of severely errored condition occurring on the DSL link. This errored card threshold is programmed into the system via the element management system. Once the threshold has been crossed, the READY LED will blink intermittent red.

A variety of statistics are maintained by the common control modules on performance of the digital subscriber line (DSL). The ATU-R reads its performance monitoring data and then forwards the data to the central office module for reporting via the element-management system. The data that is collected includes:

- **CODING VIOLATION (CV)** – A CRC error over the DSL link. Note that there are downstream coding violations and upstream. CV violations are used by the ATU-Cs to calculate Errored Seconds (ES), Severely Errored Seconds (SES), and Unavailable Seconds (UAS).
- **DSL HEC (CELL HEADER ERROR CORRECTION BYTE) ERROR SECONDS (DHES)** – A count of one-second periods where at least one HEC Error was observed.
- **SIGNAL-TO-NOISE MARGIN (SNM)** – The current signal margin recorded.
- **LINE ATTENUATION (ATTN)** – The current line attenuation recorded.

## 7. Block Diagram

Figure 4 shows a block diagram of ATU-R operation.



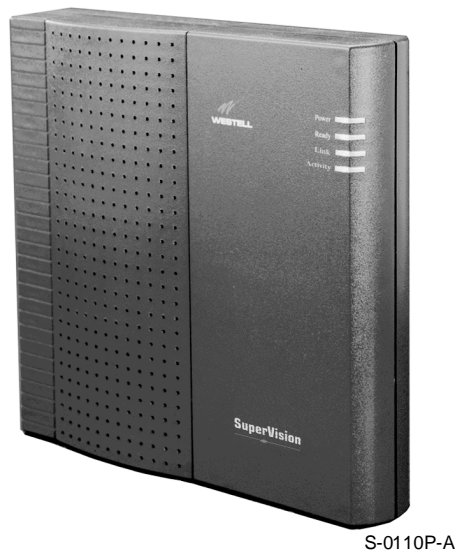
**Figure 4. 10BaseT Remote Block Diagram**

## 8. Operation

The remote unit is designed to run unattended. After it has been installed, configured, synchronized with the access line module, and passed the boot up tests, no further action is required to operate it.

## 9. Installation

The ATU-R is installed on the customer premises and not at the central office. **Figure 5** shows the remote unit.



**Figure 5. Rate-Adaptive DSL Ethernet Remote Unit**

### 9.1 Unpacking

Remove the ATU-R from the shipping box and verify the following items:



- One ATU-R Unit
- One Power Transformer (sold and packaged separately)

The following cables are required (but not supplied):

- 10BaseT Ethernet cable per IEEE 802.3
  - \* Straight through cable used for connection to a PC
  - \* Crossover cable used for connection to Ethernet hub
- 8-pin modular cable
- RJ11 6-pin modular cable

### 9.2 Installation Criteria

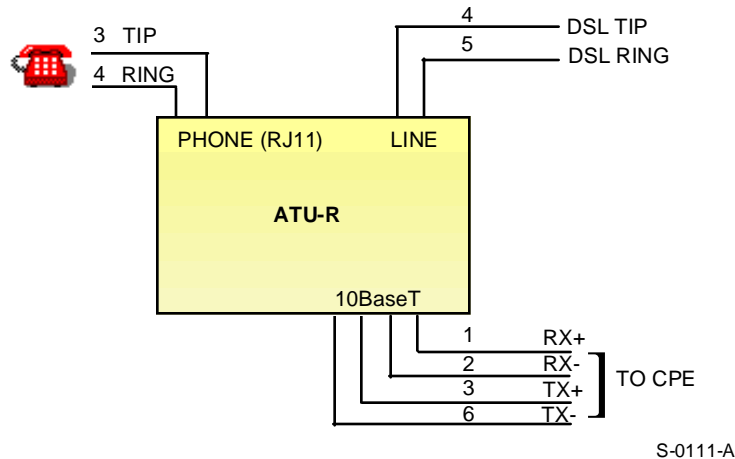
- Installation must be within 6 feet (182.88 cm) of an accessible domestic power receptacle.
- Sturdy surface providing approximately 9.8 x 9.8 inch (25 x 25 cm) of mounting surface area.
- Approximately 19.7 in. (50 cm) of front, rear, and top access clearance after the unit is surface mounted.
- Unobtrusive but accessible location.
- Will operate up to 304.8 feet (100 M) from ATU-R to computer over 100-Ohm, Cat. 5 cable.

### 9.3 ATU-R Wiring

Figures 6 and 7 show how to connect an internal POTS splitter, if applicable.



### 9.3.1 Installation with an Internal POTS Splitter

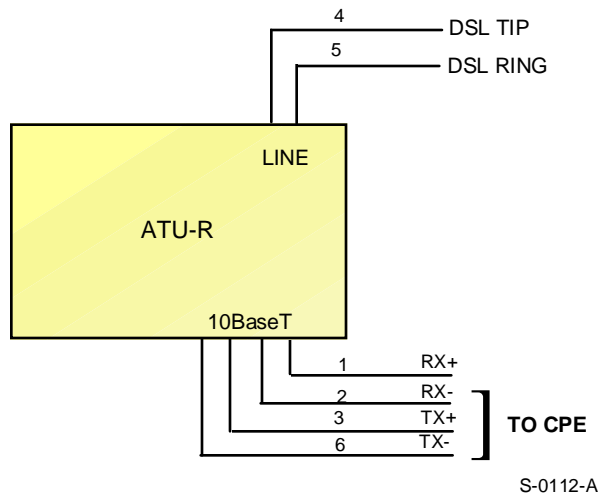


**Figure 6. Installation Diagram with an Internal POTS Splitter**

Use the following procedure:

1. Connect the power transformer to the back of the unit and then plug into the wall power receptacle.
2. Connect either an 8-pin module cable or a standard 6-pin telephone cable from the LINE connector on back of the unit to the network jack.
3. Connect the proper Ethernet cable from the 10BaseT connector to the interface on the CPE equipment (for example, the PC NIC card).
4. Connect the phone to connector phone connection on the back of the unit.
5. Power the unit ON.
6. By observing the READY LED, check the unit to ensure that the power self-test has successfully completed, and that the unit is synchronized with the access line module. It may take from 50 to 70 seconds for the unit to achieve line synchronization with the central office ADSL unit. The READY LED illuminates to a steady green to show that the unit is synchronized.
7. Verify the connection to the CPE by observing the LINK and ACTIVITY LEDs on the front of the unit.

### 9.3.2 Installation without an Internal POTS Splitter



**Figure 7. Installation Diagram *without* a POTS Splitter**

Use the following procedure:

1. Connect the power transformer to the back of the unit and then plug into the wall power receptacle.
2. Connect the 8-pin module cable or a standard 6-pin telephone cable from the LINE connector on back of the unit to a POTS splitter (refer to POTS splitter data sheet for instructions) or to the network jack if POTS service is not provided.
3. Connect the proper Ethernet cable from the 10BaseT connector on the back of the unit to the interface on the CPE equipment (for example, the PC NIC card).
4. Power the unit ON.
5. By observing the READY LED, check the unit to ensure that the power self-test has successfully completed, and that the unit is synchronized with the access line module. It may take from 50 to 70 seconds for the unit to achieve line synchronization with the central office ADSL unit. The READY LED illuminates to a steady green to show that the unit is synchronized.
6. Verify the connection to the CPE by observing the LINK and ACTIVITY LEDs on the front of the unit.

## 10. Maintenance

**DO NOT FIELD-REPAIR EQUIPMENT.** If the equipment is suspected of being faulty, see the Product Service, Repair and Return section of the SuperVision *Service/Technical Support* Section of this manual.

### WARRANTY ADVISORY

*Any attempt to repair or modify the equipment by anyone other than an authorized Westell representative will cause the warranty to be void.*

#### 10.1 Troubleshooting and Repair

If trouble is found while testing the equipment, verify that all connections are properly made and that the unit is properly optioned. Troubleshooting and repair of the unit is limited to isolating the fault to the ATU-R, then removing and replacing the ATU-R with a spare unit.



*Risk of electric shock. Voltages up to 140Vdc (with reference to ground) may be present on telecommunications circuits.*

1. Check for faulty communication/signal lines external to the ATU-R.
2. Check for communication/signal lines connected to incorrect jacks, plugs, or terminals.

If trouble persists, see the Product Service, Repair and Return procedures in the SuperVision *Service/Technical Support* Section of this manual.

#### 10.2 Visual Inspection

Visually inspect the unit for any obvious signs of a fault or damage.

- Burnt, heat blistered, or cracked plastic frame
- Loose parts within plastic frame



## 11. Specifications

### DIMENSIONS

Height – 7.5 in. (19 cm)  
Width – 7.78 in. (19.76 cm)  
Depth – 1.9 in. (4.82 cm)

### WEIGHT

2.30 lbs. (1.04 kg)

### ENVIRONMENTAL

Ambient Operating Temperature – +23 to +113°F (-5 to +45°C)  
Relative Humidity – 5 to 95%, non-condensing  
Absolute Humidity – 1 to 29 g/m<sup>3</sup>

### POWER SUPPLY

230/110 VAC (±10%) wall mount power supply

### POWER CONSUMPTION

7 Watts typical from 24 VAC

### CONNECTORS

Power – MINI-DIN connector  
DSL – one 8-pin modular jack  
Alternate POTS – 6-pin modular jack RJ11  
10BaseT Ethernet – One 8-pin modular jack

### ETHERNET CONNECTOR PINOUT

An RJ-45 type that carries the Receive data on pins 1 and 2, and the Transmit data on pins 3 and 6.

### ETHERNET INTERFACE

Provides transmit and receive data paths for 10BaseT Network Connection.

### ADSL CONNECTOR PINOUT

The ADSL connector is a RJ-45 type that carries combined ADSL and POTS signals on pins 4 and 5. The connector is compatible with an RJ11 connector with signal on pins 3 and 4.

### DSL

DSL Line Code – Carrierless Amplitude Phase Modulation (CAP)  
DSL Rates – 640 kbps to 7.1 Mbps downstream and 91 kbps to 1.088 Mbps upstream  
DSL Upstream Transmit Power – 13.3 dBm, typical  
DSL Impedance – 100 Ohms  
DSL Performance – Per Category 1 in ANSI T1.413

### POTS FILTER

Internal or external

### ELECTRICAL SAFETY—COMPLIES WITH:

Elect. safety requirements per UL 1459  
Elect. safety requirements per GR-1089-CORE, Sec 7  
Elect. requirements per EN60950  
Elect. safety requirements per CSA 22.2. No. 0.7

### COMPLIANCE

CE (Europe) – complies with 1997 CE requirements,  
CSA (Canada), UL (US), FCC Part 15, Class B (ATU-R)

### TRADEMARKS

SuperVision® is a U.S. registered trademark of Westell Technologies, Inc.  
Information Copper Highway™ is trademarks of Westell Technologies, Inc.  
AccessVision™ is a trademark of Atlantech Technologies Ltd.



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## **FCC NOTICE:**

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an output on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.